920476-907469

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the application of	:	Anslow, Peter J.
Serial No.	:	09/973,650
Filed	:	October 9, 2001
For	:	Distortion measurement in Optical Communication Systems
Examiner	:	Payne, David C.
Art Unit	:	2638
Customer number	:	23644

BRIEF ON APPEAL

Honorable Director of Patents and Trademarks
PO Box 1450
Alexandria, VA 22313-1450

Dear Sir,

This appeal is from the Examiner's final rejection of January 17, 2006 and the advisory action of June 2, 2006 in which all pending claims, that is claims 1-28 were rejected or objected to. Appropriate responses were mailed on March 17, 2006 and May 17, 2006, and a timely Notice of Appeal was mailed on June 16, 2006 with the required fee of $500.

This brief fee of $500 should be deducted from Deposit Account No. 12-0913.

(i) Real Party in Interest

This application is assigned to Nortel Networks Limited. The assignments are recorded at Reel 012240/0133.

(ii) Related Appeals and Interferences

There are no related appeals or interferences or judicial proceedings.

(iii) Status of Claims

This application was filed with claims 1 through 28. Claims 1, 6, 8, 16-19, 27 and 28 have been finally rejected by the Examiner, claims 15 and 26 have been allowed, and the remaining dependent claims objected to, but indicated to be allowable if rewritten in independent form to include the features of their base claim. The rejection of claims 1, 6, 8, 16-19, 27 and 28 in the office action of January 17, 2006 is appealed. Claims 1-28 as amended during the prosecution of the application are set forth in the Claims Appendix.

(iv) Status of Amendments

No amendments were made in the responses of March 17, 2006 and May 17, 2006, following the final rejection, but arguments were presented.

(v) Summary of Invention

The present invention relates to measuring the amplitude distortion component in an optical transmission signal subject to noise and amplitude distortion components. In particular, it involves determining the amplitude distortion component by analysing the bit error ratio (BER) of the signal as a function of a movable decision threshold.

Independent claim 1:

This claim summarizes the invention conveniently and specifies measuring the amplitude distortion component in an optical transmission signal subject to noise and amplitude distortion components, the method comprising determining the amplitude distortion component by analysing the bit error ratio (BER) of the signal as a function of a movable decision threshold.

Conventionally it is not possible to distinguish these two components of distortion in the optical transmission signal. This new analysis of the optical transmission signal is of great benefit in that as a result of distinguishing these types of distortion, better fault location or optimisation of the optical transmission system for example become possible. This in turn is important as it can lead to for example reductions in error rates or increases in bandwidth (to enable more traffic to be carried) or reach (to enable greater distance between repeaters, to reduce costs).

Figure 8 shows a pair of graphs, either of which provides a good illustration of an example of the analysis. Figure 7 (and associated description at page 6 line 27 to page 7 line 12, shows an example of apparatus to provide bit error information using the claimed movable decision threshold, to generate the information shown by the points plotted in fig 8. As shown in fig 8 (and associated description at page 7 line 13 to page 8 line 27), values V1 and V2 can be deduced from the points, and the ratio V1/V2 is a measure of the amplitude distortion component of the signal. Hence these components of the distortion can now be distinguished. An example of the steps to obtain v1/v2 will now be explained in more detail.

The points shown in fig 8 are obtained by measuring the error rate at a number of different decision thresholds, (using the apparatus of fig 7) the decision threshold being typically the level of received signal at which ones and zeroes are differentiated. In normal operation, the threshold is moved or set to minimise the

error rate, indicated by the peak in the graphs of fig 8. By moving the threshold, the points left and right of the peak can be obtained. By fitting four straight lines to the points as shown in fig 8, and finding the intersections of these lines with the x-axis, the values V1 and V2 are obtained, from which the ratio V1/V2 is obtained.

Incidentally in fig 7 the outputs of the DACs 31 and 32 are shown as V1 and V2, though it is immediately apparent that these outputs are the threshold values for comparators 24 and 25 and so are unrelated to the V1 and V2 of fig 8, and should be disregarded.

<u>Independent claim 9</u>:

This claim has corresponding distinctive features and so the discussion of claim 1 applies here. It specifies an optical transmission system comprising measuring means to measure the amplitude distortion component in an optical transmission signal subject to noise and amplitude distortion components, the measuring means adapted to measure the amplitude distortion component by analysing the bit error ratio (BER) of the signal as a function of a movable decision threshold.

The optical transmission system is illustrated in fig 7 by part 22 and optical detector 23. The measuring means are shown in fig 7 by DACs 31, 32 for supplying the movable threshold to comparators 24, 25, latches 27, 28 and error detector gate 29 and counter 30, by processor and appropriate software for carrying out the analysis described in relation to fig 8. The processor is mentioned at page 3 line 20, and can be any conventional processor. The software for running by the processor is described in the form of pseudo code, at line 20 of page 7 onwards and shown graphically in fig 8.

<u>Independent claim 15</u>:

Again, this claim has corresponding distinctive features and so the discussion of claim 1 applies here. Examples of the features of this claim are shown in fig 7, and

the appropriate reference numerals correspond to the claim features as follows. It specifies an optical transmission system, (22,23) comprising optical receiver means (23, 24, 25) to detect optical transmission signals and convert them into their electrical equivalent, clock extraction means (26) to extract clock timing signals from the received optical signals, first and second digital-to-analogue converters (31,32) providing first inputs to first and second analogue amplifiers (comparators 24,25), said optical receiver means providing second inputs to said first and second analogue amplifiers, first and second bi-stable circuit means (27, 28) connected respectively to outputs of said first and second analogue amplifiers and synchronised by said extracted clock signals, outputs of said bi-stable circuit means connected to inputs of an exclusive-OR gate (29), an output of said exclusive-OR gate providing error signals input to a counter (30), whereby said counter accumulates a count representing the bit error ratio in said received optical signals, and said digital-to-analogue converters being controlled by processor means (not shown in fig 7, but described as microprocessor at line 1 of page 7) to determine decision threshold separations V1 and V2 in the eye that represent amplitude distortion components in said received optical signals (described by pseudo code of line 20 of page 7 onwards and shown graphically in fig 8).

Independent claim 20:

Again, this claim has corresponding distinctive features and so the discussion of claim 1 applies here. Examples of the features of this claim are shown in fig 7, and the appropriate reference numerals correspond to the claim features as follows. It specifies an optical receiver (fig 7) comprising detector means (23) to detect optical signals from an optical transmission system and convert them into their electrical equivalent, the receiver comprising measuring means (24-32) to measure the amplitude distortion component in a said optical signal subject to noise and amplitude distortion components, the measuring means (items 24-32 of fig 7 controlled by processor not shown in fig 7, but described as microprocessor at line 1 of page 7) adapted to measure the amplitude distortion component by analysis of the

bit error ratio (BER) of the signal as a function of a movable decision threshold (described by pseudo code of line 20 of page 7 onwards and shown graphically in fig 8).

Independent claim 26:

Again, this claim has corresponding distinctive features and so the discussion of claim 1 applies here. Examples of the features of this claim are shown in fig 7, and the appropriate reference numerals correspond to the claim features as follows. It specifies an optical receiver (fig 7) comprising detector means (23) to detect optical signals from an optical transmission system and convert them into their electrical equivalent, clock extraction means (26) to extract clock timing signals from the received optical signals, first and second digital-to-analogue converters (31,32) providing first inputs to first and second analogue amplifiers (24,25), said optical receiver means providing second inputs to said first and second analogue amplifiers, first and second bi-stable circuit means (26,27) connected respectively to outputs of said first and second analogue amplifiers and synchronised by said extracted clock signals, outputs of said bi-stable circuit means connected to inputs of an exclusive-OR gate (29), an output of said exclusive-OR gate providing error signals input to a counter (30), whereby said counter accumulates a count representing the bit error ratio in said received optical signals, and said digital-to-analogue converters being controlled by processor means (not shown in fig 7, but described as microprocessor at line 1 of page 7) to determine decision threshold separations V1 and V2 in the eye that represent amplitude distortion components in said received optical signals (described by pseudo code of line 20 of page 7 onwards, and shown graphically in fig 8).

vi) Grounds of Rejection to be Reviewed on Appeal

There are two grounds of rejection to be reviewed in this Appeal:

(1) Claims 1, 6 and 27 have been rejected by the Examiner under 35 U.S.C. §102(b) as being anticipated by Taga U.S. 5,585,954. (Taga)

(2) Claims 8, 16-19 and 28 have been rejected by the Examiner under 35 U.S.C. §103(a) as being unpatentable over Taga in view of Scholz, et al. U.S. 5,325,397 (Scholz).

(vii) Arguments

Claims 1, 6, and 27 have been rejected for anticipation by Taga. Claims 8, 16-19 and 28 are rejected for obviousness over Taga in view of Scholz. All rejections are governed by a question of interpretation of the claim feature of determining an "amplitude distortion component" and whether Taga inherently shows such a claim feature.

The Examiner set out his summary of the issue in point 2 of the response to arguments section in the final office action of January 17, by saying that measuring Q values and Signal/Noise ratios as is done in Taga, inherently measures noise and amplitude distortion which is the whole purpose of the invention.

As the Examiner's arguments seem to rely on interpreting the claim to encompass measuring combined distortions from noise and amplitude distortions, this interpretation will be discussed first.

Applicants explained in the May 17, 2006 response it is not correct to say that measuring noise and amplitude distortion (assuming the Examiner means combined noise distortion and amplitude distortion) is the whole purpose of the invention, since claim 1 explicitly specifies "determining the amplitude distortion component" in a signal "subject to noise and amplitude distortion components". This explicit feature of the claim cannot be disregarded or interpreted to encompass determining a

combined value of the amplitude distortion component and the noise distortion component without separating these components. This cannot be a reasonable interpretation of this claim feature for two reasons: a) as a matter of language the reference in the claim to "noise and amplitude distortion components" means that "amplitude distortion component" must mean something different from "noise and amplitude distortion components" and b) because a skilled person would be aware that the noise component can easily swamp the amplitude distortion component. Hence a value of the combined noise and amplitude distortion components cannot be regarded as representative of the amplitude distortion component.

So the distinguishing feature of the claimed invention can be summarized more accurately as measuring the amplitude distortion component in an optical transmission signal subject to noise and amplitude distortion components.

Taga does not show this feature and cannot achieve this "inherently" as was explained in the last response, and reiterated here.

Taga et al. simply shows a faster way of measuring Q by using multiple decision circuits and has absolutely nothing to do with separating a noise component from an amplitude distortion component. In fact the word distortion does not occur in Taga et al.

Taga shows measuring a Q value by interpolation from a series of BER values at different decision levels in a receiver. Taga (and the present application) acknowledges it was known to sweep though these different decision values to obtain the BER values. Taga indicates that fading over time means the BER values vary during the sweep and so the interpolation contains an error depending on the amount of fading. So Taga proposes taking many decisions simultaneously by providing a signal splitter and multiple decision circuits with different decision levels. This type of Q measurement provides a value which can be regarded as

representing the ratio of the eye opening to the noise. It cannot provide a value of the eye opening itself. So the Q measurement in Taga is a form of signal to noise ratio, but provides no information about any amplitude distortion component.

It is therefore possible to have two optical signals with the same Q value where one signal has a large amplitude distortion component (and therefore a small eye opening), but has a small noise component and the other signal has small amplitude distortion component (and therefore a large eye opening) and a large noise component.

Measurement of these two signals according to Taga et al would give the same resulting Q and would not distinguish between them. Therefore Taga cannot inherently determine an amplitude distortion component in a signal having amplitude and noise components as claimed. Embodiments of the claimed invention could also give the same Q value, but in contrast to Taga, would also provide a measure of the amplitude distortion component (based on eye opening) alone.

The Examiner says that Taga measures Q on signals subject to distortion. This is true, but since Taga fails to show determining an amplitude distortion component separately from the noise component, it cannot "inherently" measure amplitude distortion.

In the advisory action the Examiner had the opportunity to consider this explanation of Taga, but made no response other than to state it was "unconvincing", without indicating which if any part of this explanation he found "unconvincing".

Thus, the Examiner's first ground of rejection for anticipation is clearly in error, and the obviousness rejection falls away for the same reasons.

Reversal of the Examiner's rejections is respectfully requested.

August 11, 2006

Respectfully submitted,

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Claims Appendix

1. A method of measuring the amplitude distortion component in an optical transmission signal subject to noise and amplitude distortion components, the method comprising determining the amplitude distortion component by analysing the bit error ratio (BER) of the signal as a function of a movable decision threshold.

2. A method as claimed in Claim 1, wherein the analysis is performed in a high bit error ratio area of the function, away from a center of an eye, and in a low bit error ratio area closer to the centre of the eye.

3. A method as claimed in Claim 2 , wherein the analysis comprises the steps of:
determining BER values as a function of the position of said movable decision threshold in said high bit error ratio area and in said low bit error ratio area;
extrapolating the BER values in both the high bit error ratio area and the low bit error ratio area to obtain respective first and second decision threshold values corresponding to a predetermined value of BER in both the high bit error ratio area and the low bit error ratio area;
determining the difference V1 between said first and second decision threshold values in the low bit error ratio area;
determining the difference V2 between said first and second decision threshold values in the high bit error ratio area; and
determining the ratio V1/V2 as a measure of the amplitude distortion component of the signal.

4. A method as claimed in Claim 3, wherein said predetermined value of BER is 0.25.

5. A method as claimed in Claim 1, wherein said analysis is performed on values of BER after Q conversion in accordance with the function $Q = 2^{1/2}\mathrm{erfc}^{-1}(4\mathrm{x}BER)$, in which *erfc* is the complementary error function.

6. A method as claimed in Claim 1, further comprising the step of providing said BER values by comparing the said signal with a said variable decision threshold.

7. A method as claimed in Claim 2, further comprising the steps of:
estimating a second bit error ratio by projecting BER values from said first and second decision threshold values in the high bit error ratio area and at the same gradient as said extrapolations in the lower bit error ratio area; and
determining the intersection of said projected BER values to obtain an estimated BER value, indicative of an optical signal-to-noise ratio of said optical signal.

8. A method as claimed in Claim 1, performed by a programmed computer.

9. An optical transmission system comprising measuring means to measure the amplitude distortion component in an optical transmission signal subject to noise and amplitude distortion components, the measuring means adapted to measure the amplitude distortion component by analysing the bit error ratio (BER) of the signal as a function of a movable decision threshold.

10. An optical transmission system as claimed in Claim 9, wherein said measuring means is adapted to perform said analysis in a high bit error ratio area of the function, away from a center of an eye, and in a low bit error ratio area closer to the centre of the eye.

11. An optical transmission system as claimed in Claim 10, wherein said measuring means comprises:

BER determining means to determine BER values as a function of the position of said movable decision threshold in said high bit error ratio area and in said low bit error ratio area;
BER extrapolating means to extrapolate the BER values in both the high bit error ratio area and the low bit error ratio area to obtain respective first and second decision threshold values corresponding to a predetermined value of BER in both the high bit error ratio area and the low bit error ratio area;
first difference determining means to determine the difference V1 between said first and second decision threshold values in the low bit error ratio area;
second difference determining means to determine the difference V2 between said first and second decision threshold values in the high bit error ratio area; and
dividing means to determine the ratio V1/V2 as a measure of the amplitude distortion component of the signal.

12. An optical transmission system as claimed in Claim 11, wherein said predetermined value of BER is 0.25.

13. An optical transmission system as claimed in Claim 9, wherein said analysis is performed on values of BER after Q conversion in accordance with the function $Q = 2^{1/2}\mathrm{erfc}^{-1}(4\mathrm{xBER})$, in which *erfc* is the complementary error function.

14. An optical transmission system as claimed in Claim 9, further comprising comparing means to provide said BER values by comparing the said signal with a said variable decision threshold.

15. An optical transmission system, comprising optical receiver means to detect optical transmission signals and convert them into their electrical equivalent, clock extraction means to extract clock timing signals from the received optical signals, first and second digital-to-analogue converters providing first inputs to first and second analogue amplifiers, said optical receiver means providing second inputs to

said first and second analogue amplifiers, first and second bi-stable circuit means connected respectively to outputs of said first and second analogue amplifiers and synchronised by said extracted clock signals, outputs of said bi-stable circuit means connected to inputs of an exclusive-OR gate, an output of said exclusive-OR gate providing error signals input to a counter, whereby said counter accumulates a count representing the bit error ratio in said received optical signals, and said digital-to-analogue converters being controlled by processor means to determine decision threshold separations V1 and V2 in the eye that represent amplitude distortion components in said received optical signals.

16. A computer program adapted to perform the method steps of Claim 1.

17. A carrier on which is stored a program adapted to perform the method steps of Claim 1.

18. An optical transmission system incorporating a processor programmed to perform the method claimed in Claim 1.

19. An optical transmission system incorporating a processor adapted to operate in response to a carrier as claimed in Claim 17.

20. An optical receiver comprising detector means to detect optical signals from an optical transmission system and convert them into their electrical equivalent, the receiver comprising measuring means to measure the amplitude distortion component in a said optical signal subject to noise and amplitude distortion components, the measuring means adapted to measure the amplitude distortion component by analysis of the bit error ratio (BER) of the signal as a function of a movable decision threshold.

21. An optical receiver as claimed in Claim 20, wherein said measuring means is adapted to perform said analysis in a high bit error ratio area of the function, away from a center of an eye, and in a low bit error ratio area closer to the centre of the eye.

22. An optical receiver as claimed in Claim 21, wherein said measuring means comprises:

BER determining means to determine BER values as a function of the position of said movable decision threshold in said high bit error ratio area and in said low bit error ratio area;

BER extrapolating means to extrapolate the BER values in both the high bit error ratio area and the low bit error ratio area to obtain respective first and second decision threshold values corresponding to a predetermined value of BER in both the high bit error ratio area and the low bit error ratio area;

first difference determining means to determine the difference V1 between said first and second decision threshold values in the low bit error ratio area;

second difference determining means to determine the difference V2 between said first and second decision threshold values in the high bit error ratio area; and

dividing means to determine the ratio V1/V2 as a measure of the amplitude distortion component of the signal.

23. An optical receiver as claimed in Claim 22, wherein said predetermined value of BER is 0.25.

24. An optical receiver as claimed in Claim 20, wherein said analysis is performed on values of BER after Q conversion in accordance with the function:

$Q = 2^{1/2}\mathrm{erfc}^{-1}$ (4xBER), in which *erfc* is the complementary error function.

25. An optical receiver as claimed in Claim 20, further comprising comparing means to provide said BER values by comparing the said signal with a said variable decision threshold.

26. An optical receiver comprising detector means to detect optical signals from an optical transmission system and convert them into their electrical equivalent, clock extraction means to extract clock timing signals from the received optical signals, first and second digital-to-analogue converters providing first inputs to first and second analogue amplifiers, said optical receiver means providing second inputs to said first and second analogue amplifiers, first and second bi-stable circuit means connected respectively to outputs of said first and second analogue amplifiers and synchronised by said extracted clock signals, outputs of said bi-stable circuit means connected to inputs of an exclusive-OR gate, an output of said exclusive-OR gate providing error signals input to a counter, whereby said counter accumulates a count representing the bit error ratio in said received optical signals, and said digital-to-analogue converters being controlled by processor means to determine decision threshold separations V1 and V2 in the eye that represent amplitude distortion components in said received optical signals.

27. An optical signal received by an optical receiver as claimed in Claim 20.

28. A computer programmed to perform the method of Claim 1.

Evidence Appendix and Related Proceedings Appendix

There are no such appendices.

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